digital™

Data Communications and Networks

EY-L307E-HO.E003

Data Communications and Networks

EY-L307E-HO.E003

DATA COMMUNICATIONS
AND
NETWORKS

Copyright © 1989, Digital Equipment Corporation

All Rights Reserved

The reproduction of this material, in part or whole, is strictly prohibited. For copy information, contact the Educational Services Department, Digital Equipment Corporation, Reading.

The information in this document is subject to change without notice and should not be construed as a commitment by Digital Equipment Corporation. Digital Equipment Corporation assumes no responsibility for any errors that may appear in this document.

Digital Equipment Corporation assumes no responsibility for the use or reliability of its software on equipment that is not supplied by Digital.

CONTENTS

Topology Terminology and Concepts 4

Modems and Modulation 17

Interface Standards 25

Communication Media 38

Protocols and Error Correction 46

Multiplexing 63

Network Architectures and the OSI Model 71

Technologies for Local Area Networks 85

Packet Switched Data Networks 112

Future Technologies 123

Appendix: Common Standards, Glossary 139

DATA COMMUNICATIONS CONCEPTS

All communications work on the principle that information is passed between:

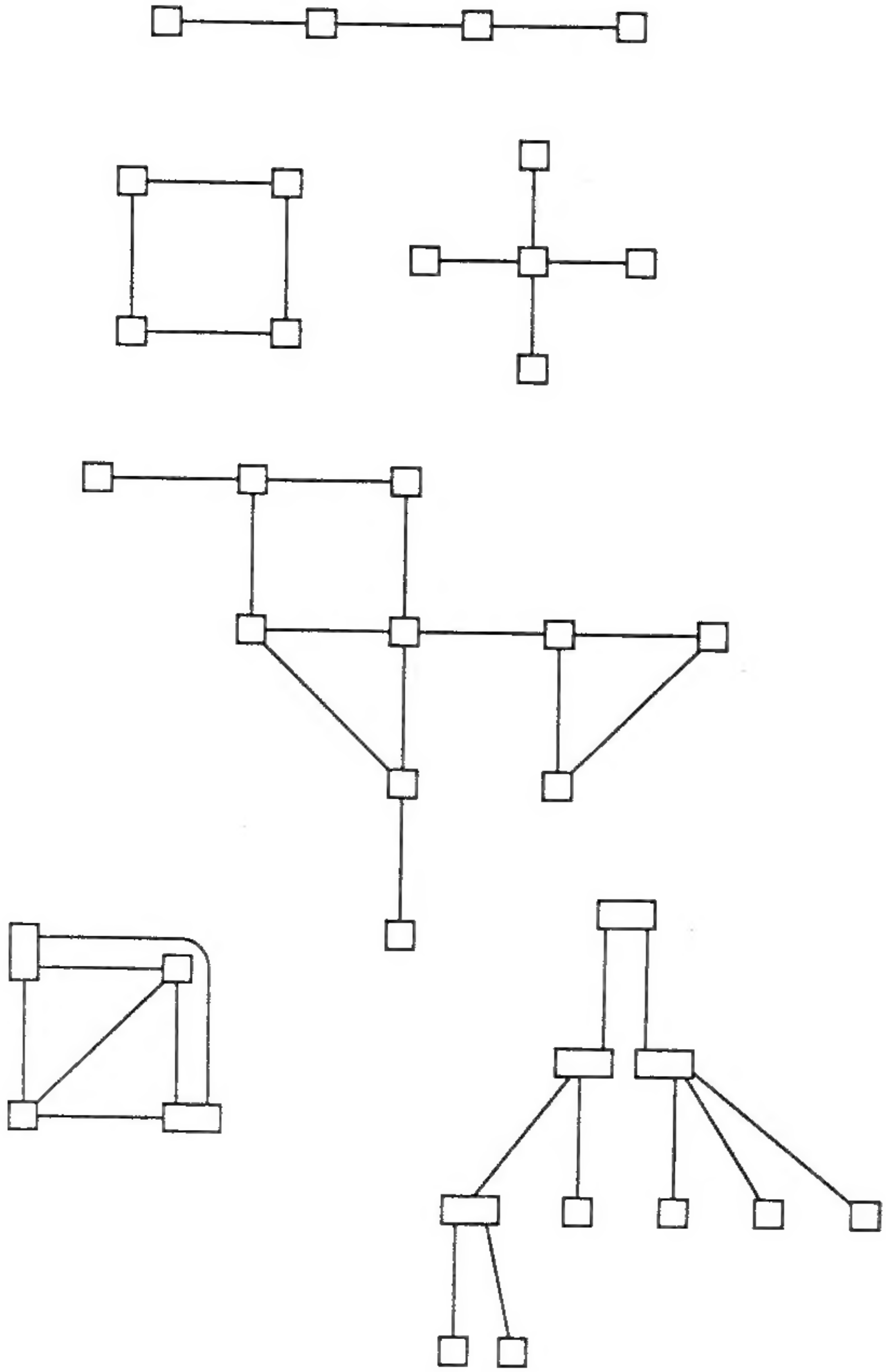
- A Transmitter (TX)
- A Receiver (RX)

An electronic link is required to connect the transmitter with the receiver to allow transfer of information, this could consist of:

- Simple direct wire connection
- Telephone line
- Microwave radio link
- Satellite link
- Fibre Optic cable

NETWORK TOPOLOGIES

POINT TO POINT



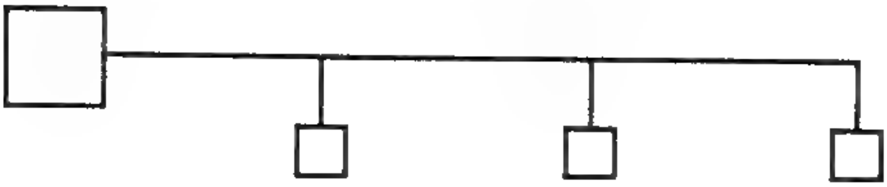
NETWORK TOPOLOGIES

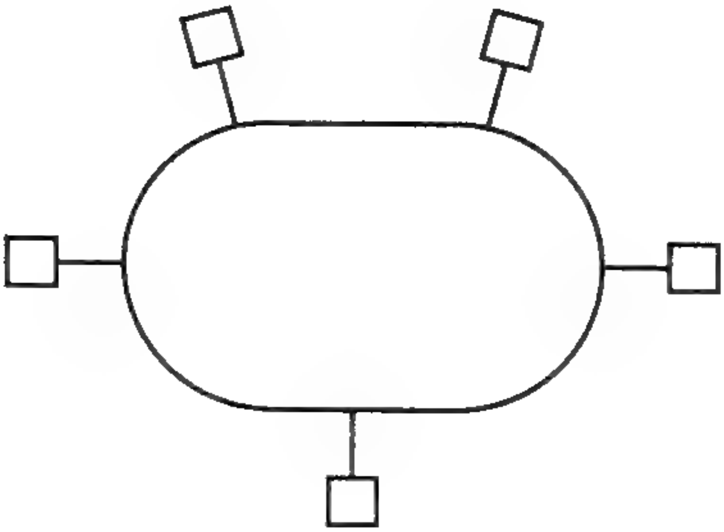
POINT TO POINT

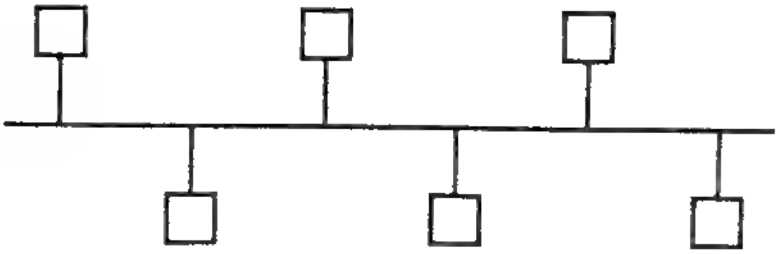
Description	No. of I/F	Relationship	WAN or LAN

NETWORK TOPOLOGIES

MULTIPOINT / MULTI-ACCESS





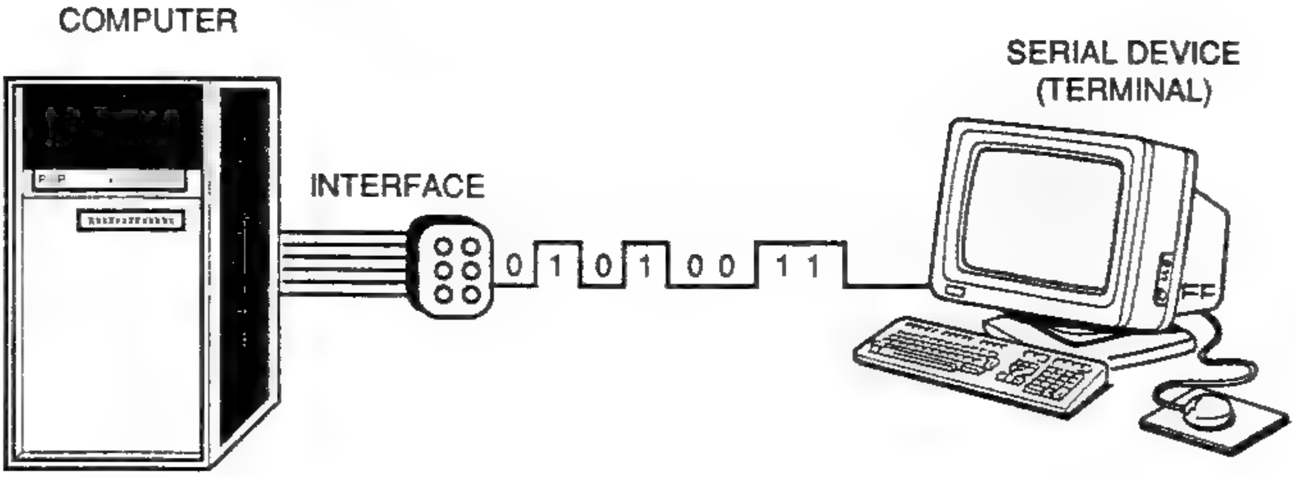


NETWORK TOPOLOGIES

MULTIPOINT / MULTI-ACCESS

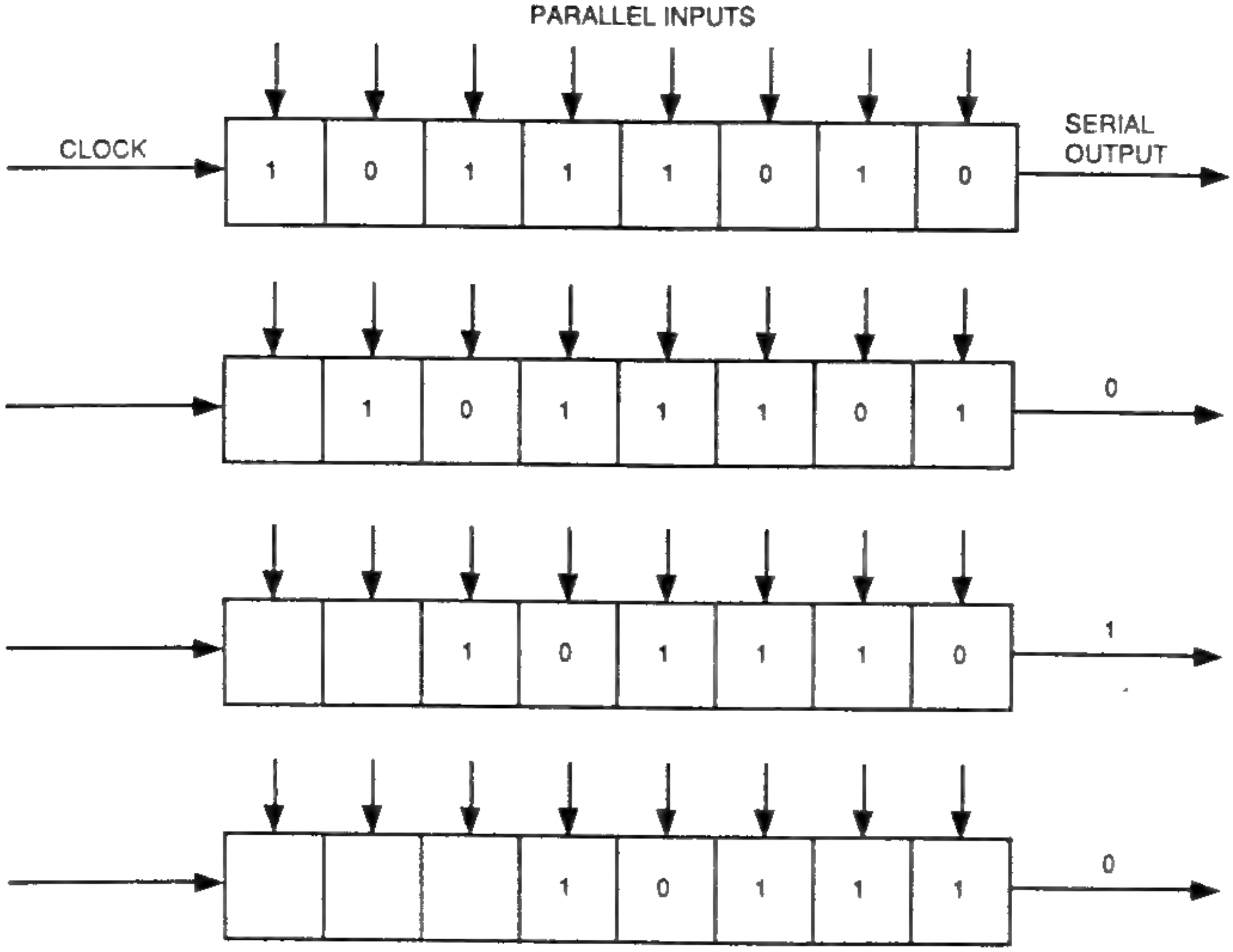
Description	No. of I/F	Relationship	WAN or LAN

SERIAL COMMUNICATION



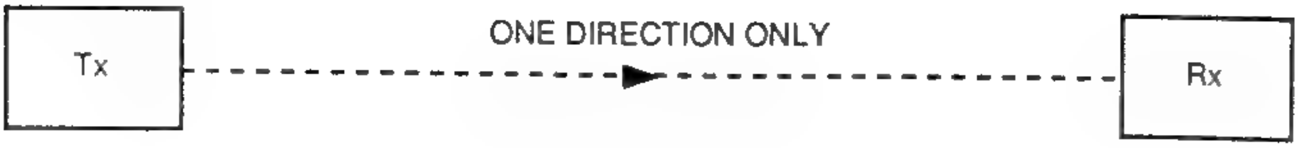
COMMUNICATION INTERFACE

- **Parallel/Serial Conversion**

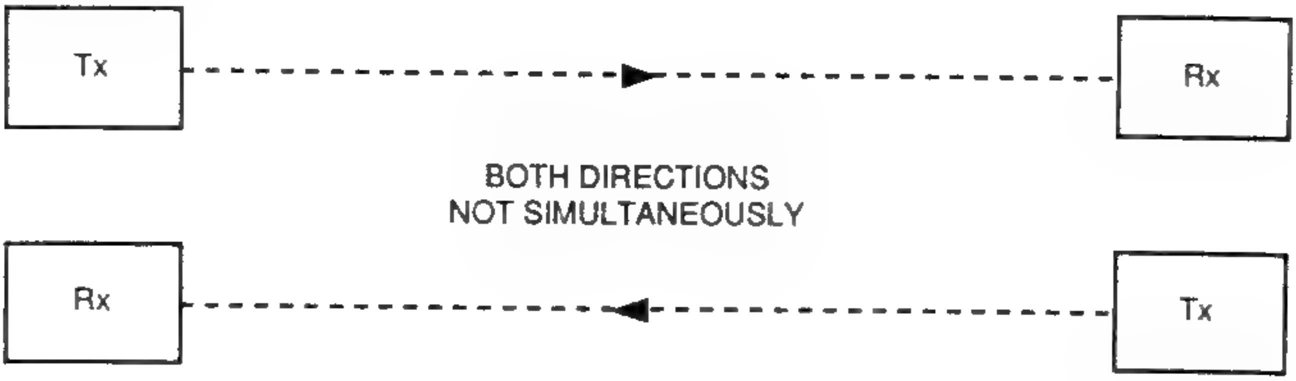


DIRECTION

SIMPLEX

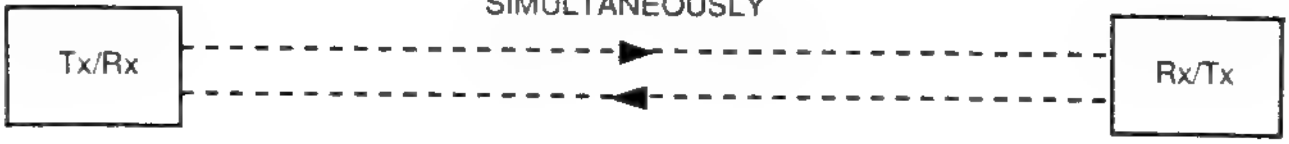


HALF DUPLEX



FULL DUPLEX

BOTH DIRECTIONS
SIMULTANEOUSLY

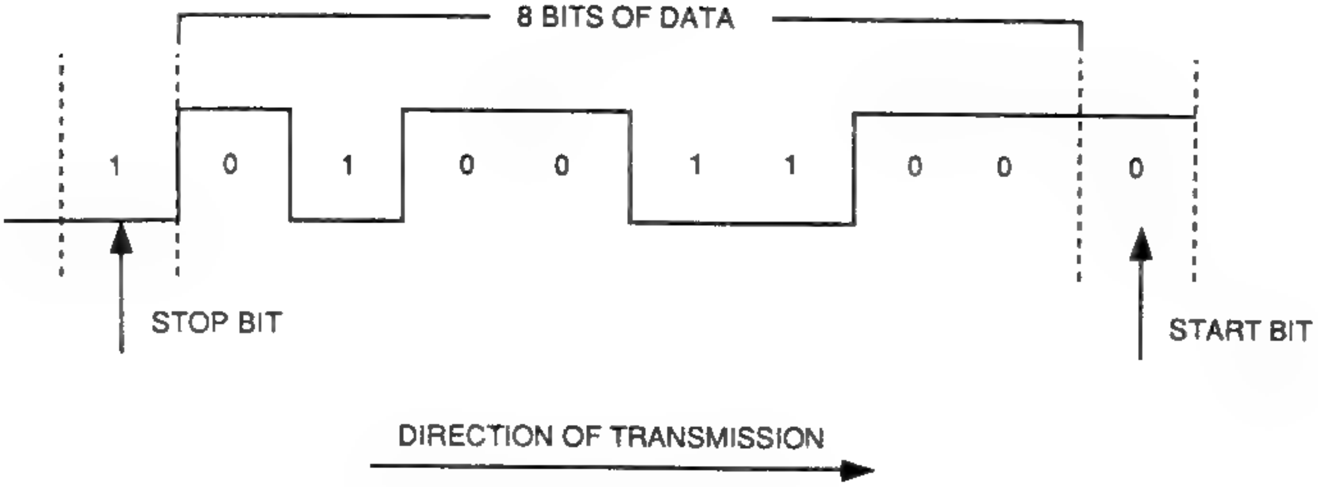


ASYMETRIC DUPLEX

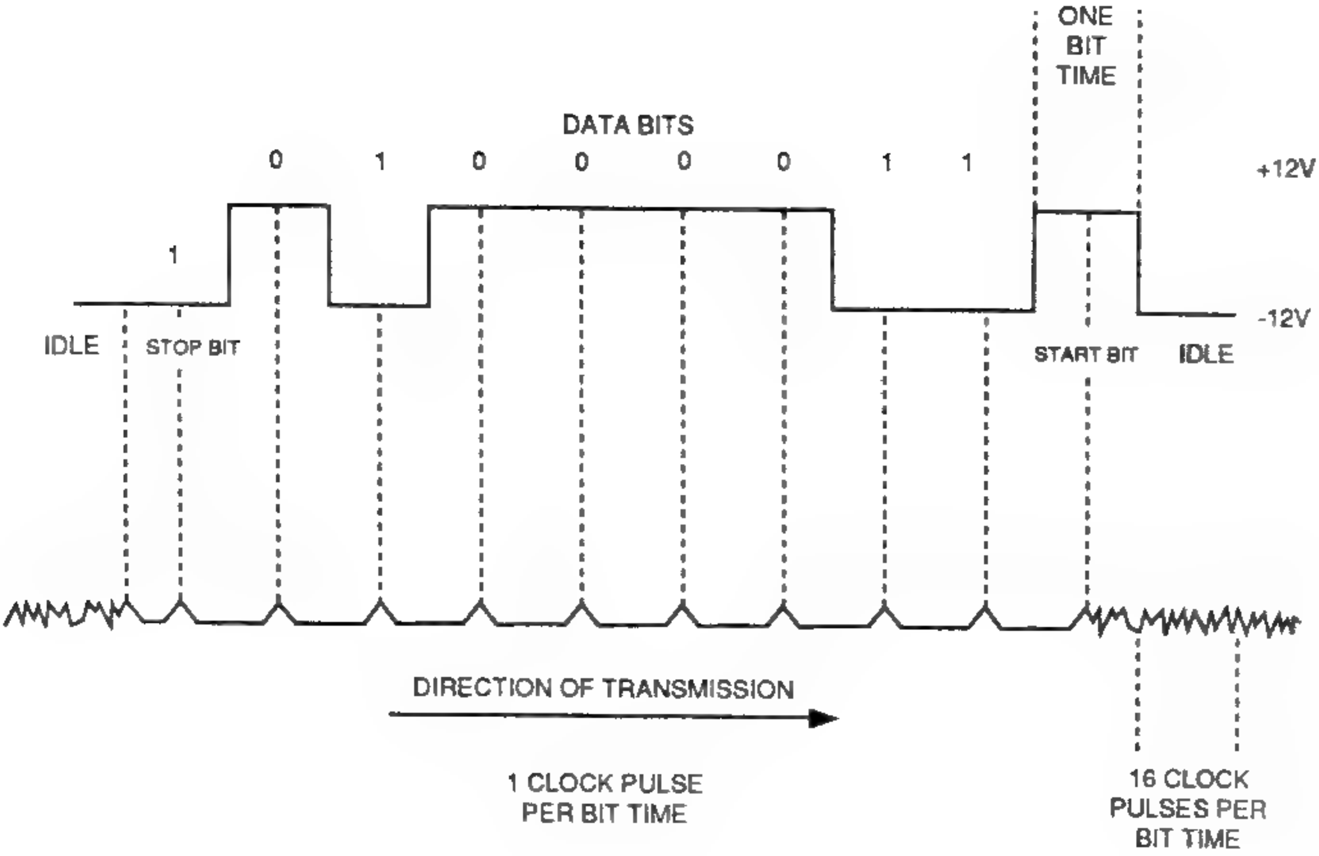
AS ABOVE-
DIFFERENT SPEEDS

ASYNCHRONOUS

- **Typical Asynchronous Character Frame**



SAMPLING OF BITS DURING ASYNCHRONOUS SERIAL TRANSMISSION


ONE
BIT
TIME
DATA BITS
0
1
0
0
0
0
1
1
+12V
1
-12V
IDLE
STOP BIT
START BIT
IDLE
DIRECTION OF TRANSMISSION
1 CLOCK PULSE PER BIT TIME
16 CLOCK PULSES PER BIT TIME

ASYNCHRONOUS SERIAL DATA TRANSMISSION TECHNIQUES

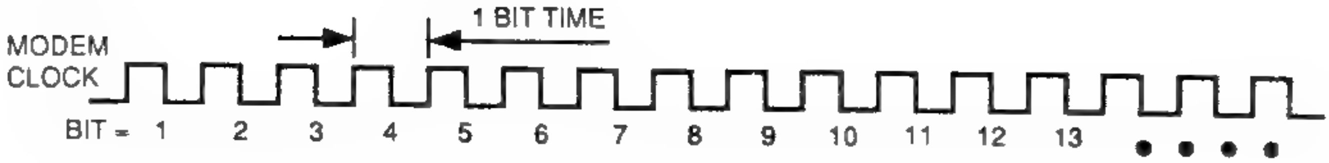
ADVANTAGES

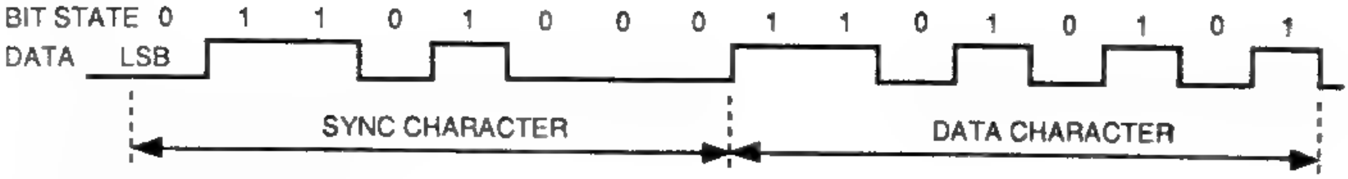
- Asynchronous serial code can easily be generated by electromechanical equipment (e.g. teletype keyboard).
- Asynchronous serial code can easily be used to drive mechanical equipment (e.g. type printers).
- Characters themselves can be sent at random times because each character has its own bit synchronizing information.

DISADVANTAGES

- It requires timing circuits for both transmitter and receiver.
- It is noise sensitive because the receiver depends upon incoming signal sequences to become synchronized.
- It is low speed because a reasonable amount of margin must be built in to accommodate distortion and compatibility with other low-speed equipment.
- It is inefficient because extra bit times are required to send 8-data bits.
  If a two unit stop code is used, it takes 11 bits of time to transfer 8 bits of data.

TYPICAL SYNCHRONOUS TRANSMISSION





LSB = LESS SIGNIFICANT BIT

SYNCHRONOUS SERIAL DATA TRANSMISSION TECHNIQUES

ADVANTAGES

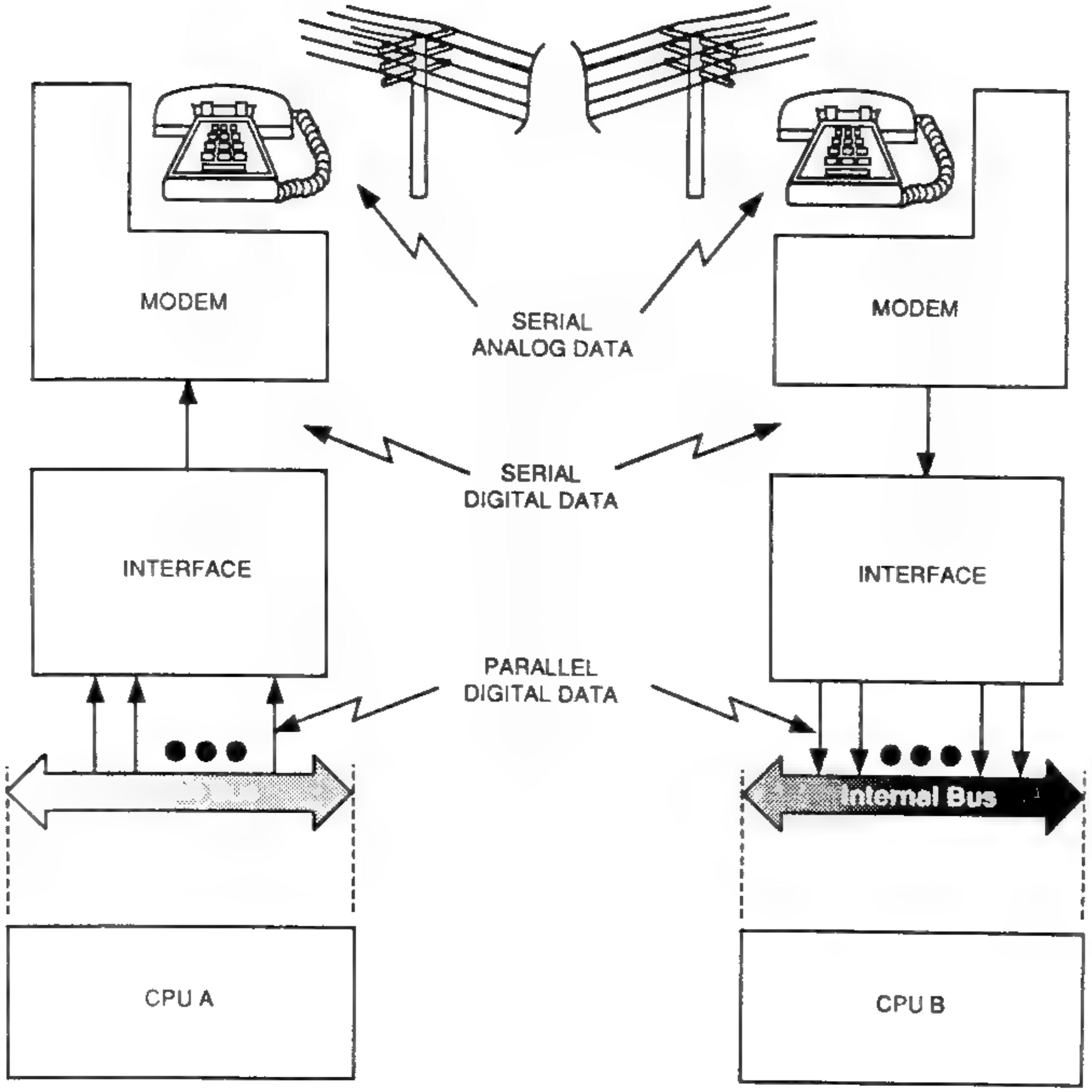
- Both transmitter and receiver use the same timing signal.
- The receiver does not require bit synchronizing.
- No bit times are wasted with the use of start and stop bits. All bits on the line are data.
- Low distortion sensitivity.
- Higher speeds are achievable because of the low distortion sensitivity.

DISADVANTAGES

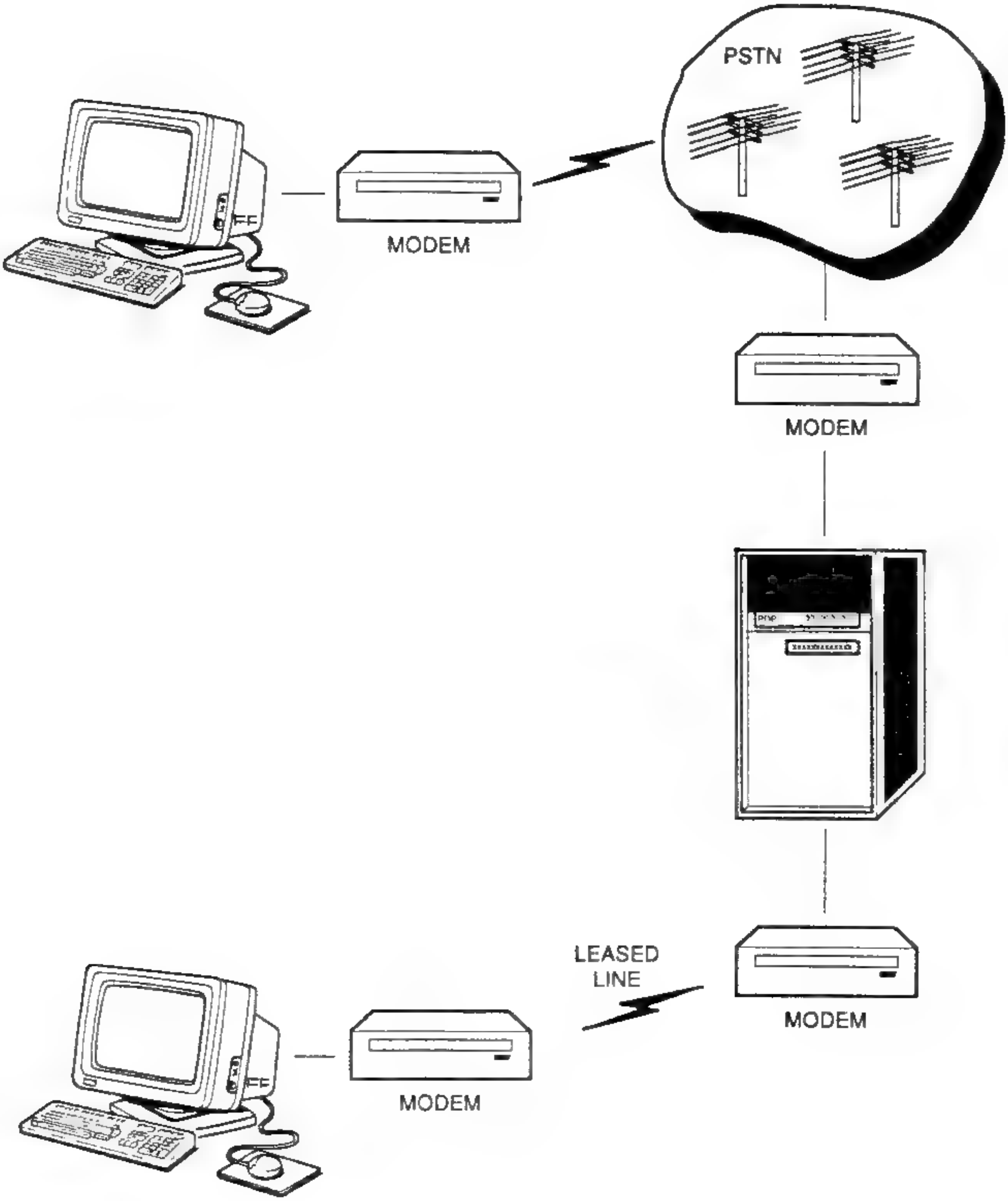
- Characters must be stored and sent in blocks rather than asynchronously as they become available.
- One bit-time added to or missing from the data-bit stream can cause the entire message to be faulty.
- The common-carrier equipment to accommodate this mode of operation is more expensive than the equipment required for asynchronous operation.
- Mechanical equipment cannot transmit or receive this format directly.

MODEMS
AND
MODULATION

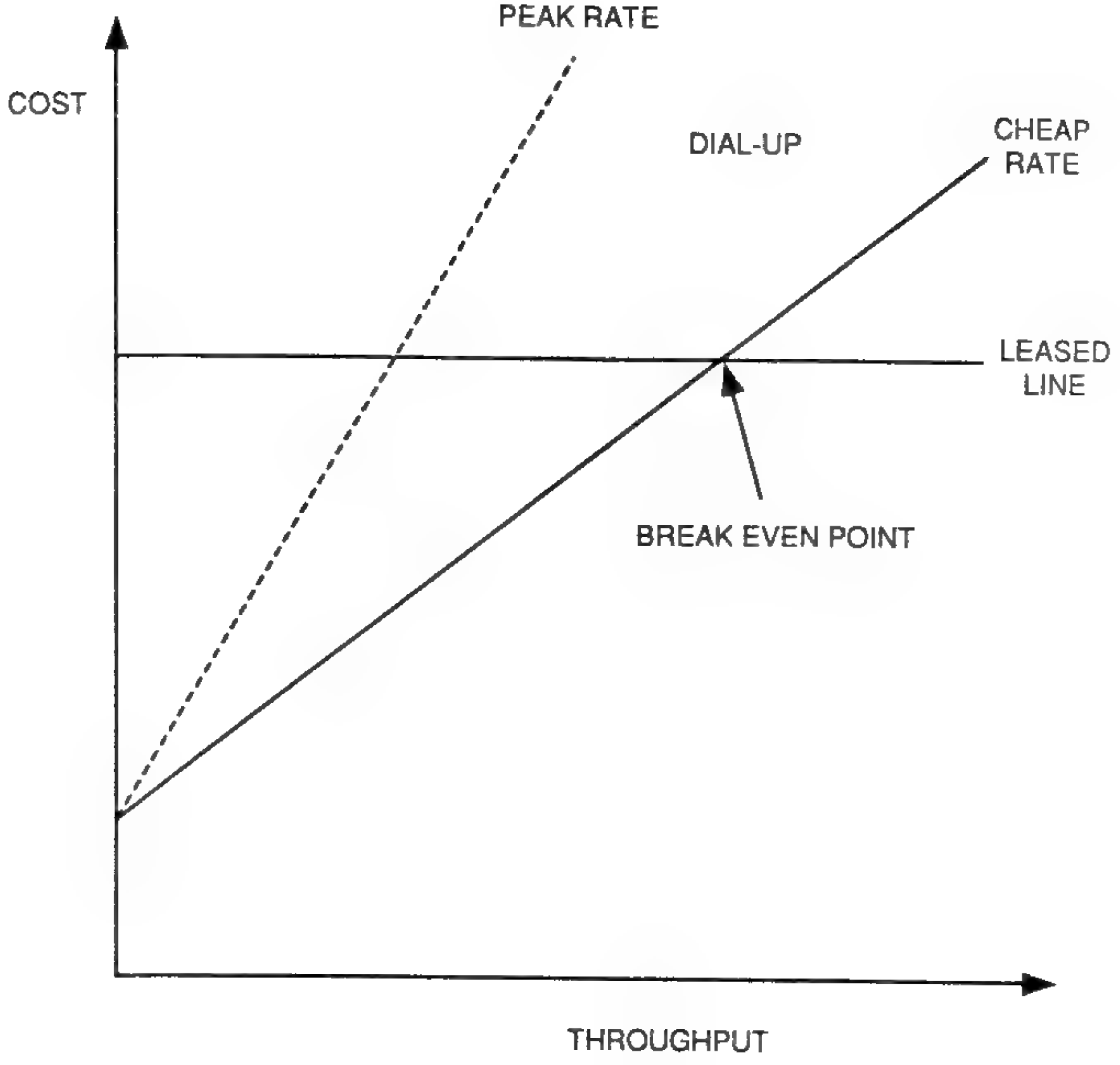
BASIC DATA FLOW IN DATA COMMUNICATIONS



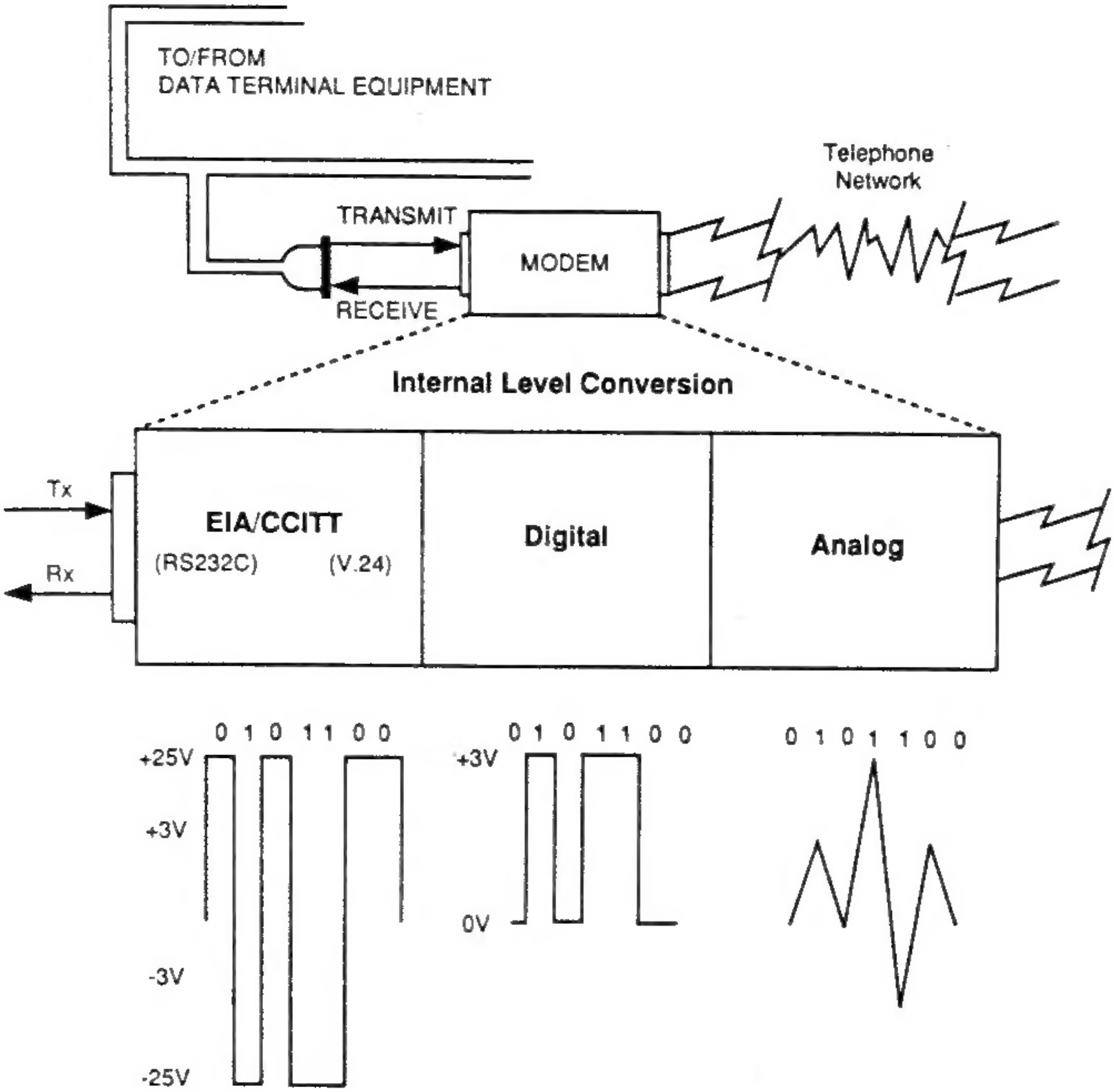
DIAL-UP OR LEASED LINE



IDEALISED COST COMPARISON

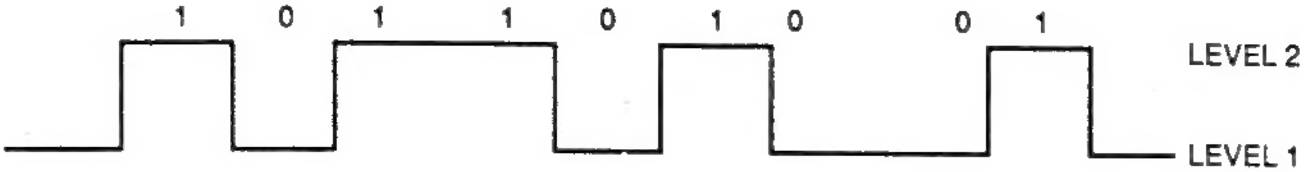


BASIC PARTS OF A MODEM

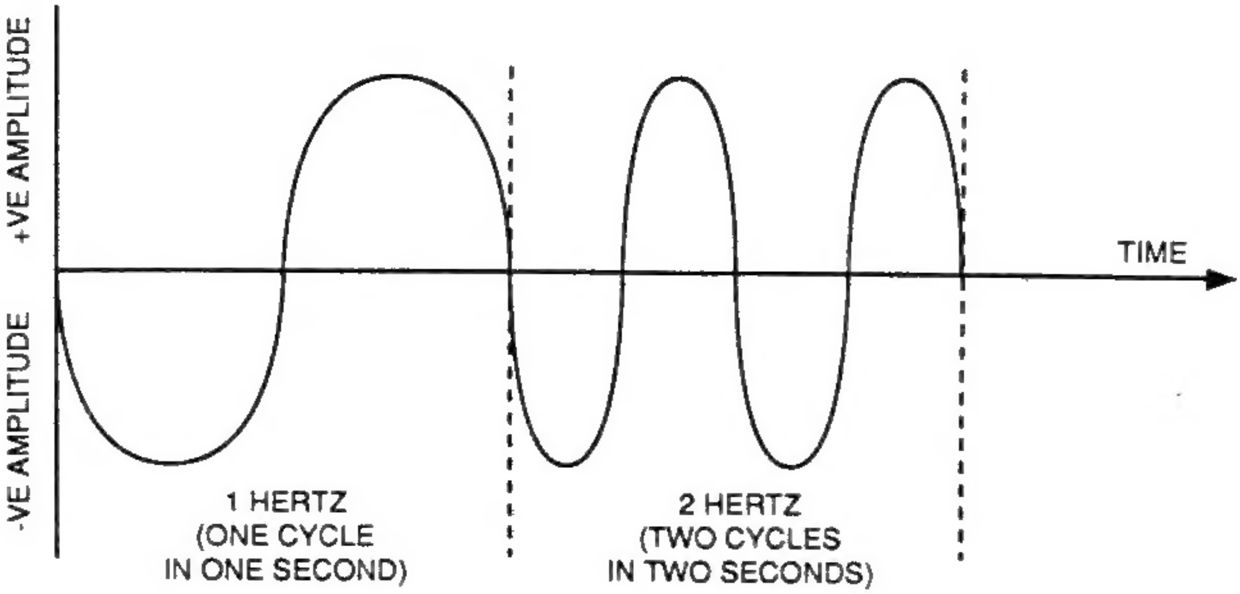


DIGITAL AND ANALOGUE SIGNALS

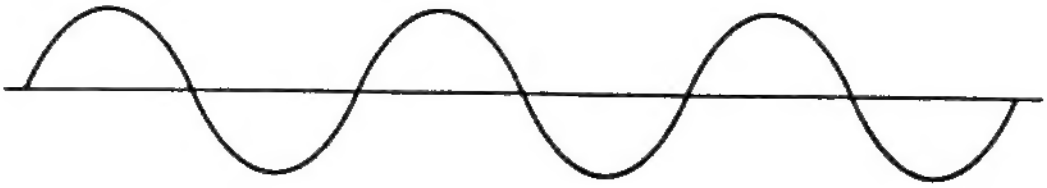
- **DIGITAL SIGNAL**



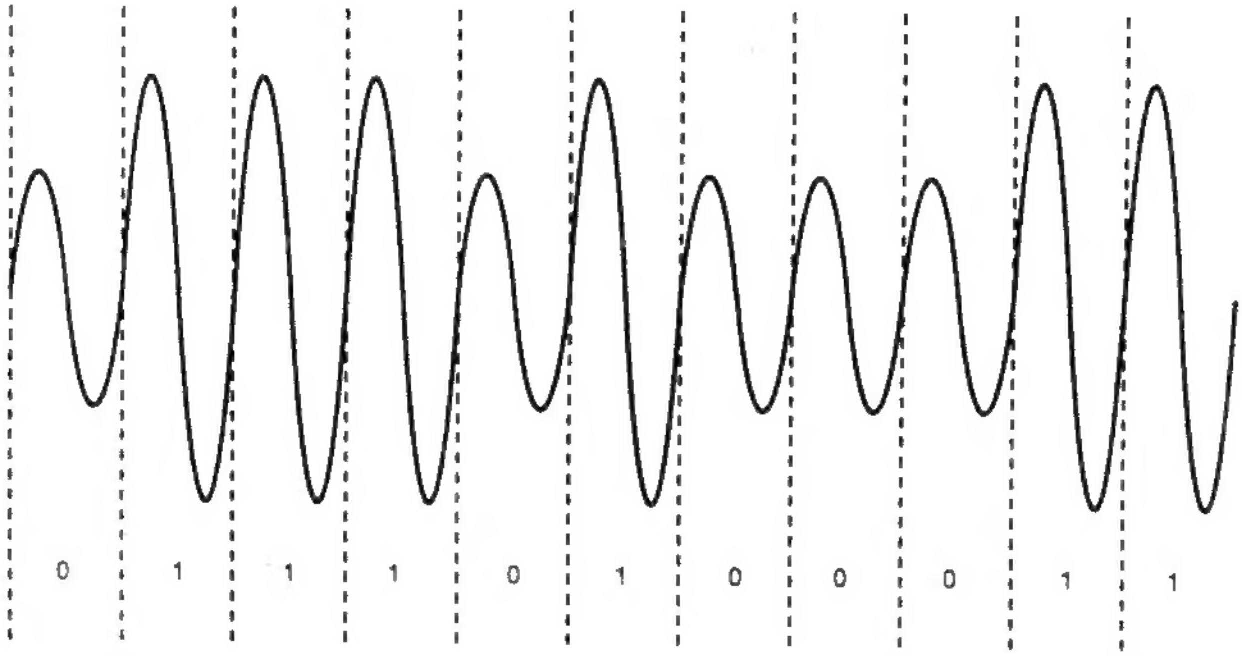
- **ANALOGUE SIGNAL**



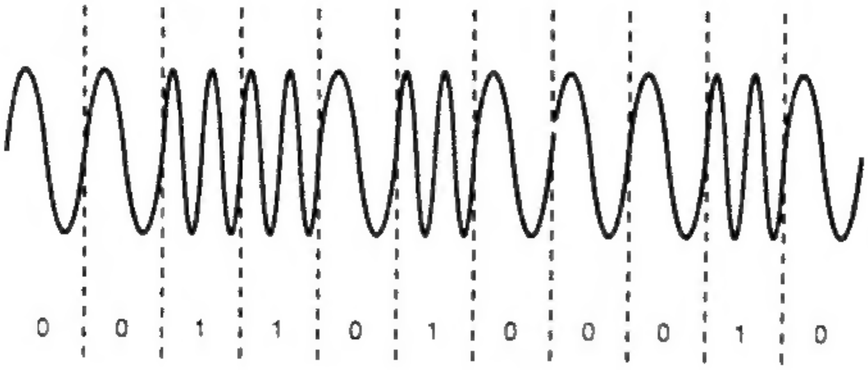
UNMODULATED CARRIER SIGNAL



Amplitude Modulation



Frequency Modulation



Phase Modulation